had good reason for supposing, with Ehrenberg, that the carbonate of lime of which they are composed was derived from decayed Foraminifera; but at the same time a strict proof would have been wanting, and we might have adopted the opinion expressed by Haidinger in his paper on the Metamorphism of Rocks *, and concluded that, though, according to Ehrenberg, chalk does contain very many organic bodies, it does itself consist of rounded forms, which are a chemical deposit from water containing soluble salts of lime. Now, however, that their real origin appears to be established, it is no longer requisite to assume the existence of any unknown crystalloidal force differing from simple crystallization; and we can clearly perceive that, though presenting characteristic differences, chalk is in every respect analogous to what we should have, if the mud now being formed at great depths in the Atlantic, by the accumulation of various minute organic bodies, were to be subsequently more or less altered by molecular changes or chemical actions of a well-known character. There is, however, one striking difference; for the Atlantic mud contains many Diatomaceæ, spicula of Sponges, and other silicious organic bodies, which are very rare in, or absent from, the chalk: it contains, however, silicious concretions; and this contrast in the state and aggregation of the silicious matter in the two otherwise analogous deposits makes me very much inclined to conclude, with Ehrenberg †, that the silex of the flints was derived from disseminated silicious organic bodies, which has collected round various centres of segregational attraction,—though there are some difficulties to remove before that opinion can be finally adopted.

XX.—*On the Sexual Life of Plants, and Parthenogenesis.* By Dr. H. Karsten, Lecturer on Botany at the University of Berlin.

[Concluded from page 99.]

Embryogeny.

The elongated pollen-cells on the stigma of *Cœlebogyne ilicifolia* exhibit no peculiarity in the onward course they pursue to the nucleus of the ovule. The amylum and the vesicles with nitrogenous contents (mucus-vesicles) become dissolved as the pollen grows; and when the pollen-tube has reached the large embryo-sac, it is seen to be filled with fluid, which also in all probability contains a number of vesicles, freely swimming about in it, some with and others without nuclei.

* Haidinger's Wiener Mittheilungen, 1848, iv. 103; Neues Jahrbuch für Mineralogie, 1849, 213.

† Abhandlungen d. k. Ak. d. Wiss. zu Berlin, 1838, 82.

One, or, it may be, two of these free cells attach themselves to the wall of the embryo-sac, with which the pollen-tube is in contact; and thereupon a process of cell-multiplication commences. Not seldom this process goes on for a time in the two germinal cells which may be present; but as a rule, one of them preponderates, and alone proceeds in forming the germinal mass (Pl. X.).

What part the pollen-sac takes in the process—whether its wall, which separates the germinal cell and the embryo-sac, be absorbed, or whether its contents, on becoming fluid, are simply diffused through it by exosmosis—cannot be satisfactorily decided by direct examination.

The larger proportion of the rudimentary cells contained in the fluid of the pollen-tube at the time this comes into contact with the embryo-sac serves for the formation of the albumen which is disposed around the growing germ (Pl. X.).

That the embryo could be formed without the action of the pollen-tube, as Radlkofer and Braun assume because Radlkofer and Deeke frequently failed in detecting the pollen-tube, is an idea no one will accept who is conversant with this kind of investigation, which, in spite of the greatest dexterity and practice, may frequently fail to exhibit in many plants the pollen-tube, which nevertheless undoubtedly exists.

The interesting question, whether, for the complete formation of two germs which are frequently at first simultaneously developed, the action of more than one pollen-tube is necessary, still remains to be answered.

The germinal cells appear, at the time of their first formation, like very delicate-walled vesicles (termed vacuoles); indeed, they seem to be present in the embryo-sac before the pollen-tube reaches it; at least, these cells are often to be seen when the pollen-tube is undiscoverable, although this certainly can never afford evidence that it actually does not exist.

In some of the free swimming-vesicles, whose walls become thicker and more perceptible, a new vesicle arises, which is usually called the nuclear corpuscle, because the free swimming-cells which contain these very small secondary (daughter-) cells have been distinguished as cell-nuclei, on the supposition that a cellulose-layer is deposited around them as the membrane of a cell which served as nucleus to this originally existing cell. This, however, is not correct; for, on the contrary, the membrane itself, the vesicle contained within it, and the daughter-cells or the nuclear corpuscles extend themselves simultaneously by means of cellulose, and one or several small new cells make their appearance in them.

In the embryo-sac the observer has all the different stages of cell-development before his eyes at the same time, and yet he is without a clue to the order of their origin; consequently his judgment may be at fault whether to admit that the outer cell is gradually deposited, in a laminated fashion, upon the inmost cell or nuclear corpuscle, or that the inner cells originate in the fluid contents of the external cells, which in the mean time expand.

In my Dissertation published in 1843, I remarked on the existence of the "daughter-cell," subsequently termed by Mohl the primordial utricle, and have very many times since recurred to this subject, and I still deem it incumbent on me again to make the assertion that the formation of a cell-membrane as a deposit on a mucoid, cellular, &c., nucleus, has, according to my repeated and careful investigations of the subject, no existence in nature. Statements of the sort have arisen wholly from incorrect views of what has been observed, because the phenomena of growth of the membrane and of the chemical changes of the cell-matter were not understood; and I may be allowed to commend to the consideration of physiologists my paper in Poggendorff's Annalen as peculiarly pertinent to the matter in discussion respecting the transformations of cellulose in the progress of growth.

The physico-chemical processes in which the phenomena of cell-growth consist must of necessity be rightly apprehended before we can hope to understand the complicated physiological phenomena of the organism.

In the case of *Cœlebogyne*, I am unable, from the want of material, as before said, to assert positively whether the cellular contents had been given birth to before the arrival of the pollen-tube in the embryo-sac—as is probable, because we are acquainted with cases where albuminous tissue is commenced about barren (non-germinating) seeds—or whether the cell-contents first arise as a consequence of the action of the pollen-tube; and further, whether the commencement of germ-growth in some of these cells is induced by the contiguity of the pollen-tube, or if an actual contact of the two is needed. This relation is of moment in making the comparison between the commonly occurring single germ of the Phanerogamia and vascular Cryptogamia and the usually numerous germs of the cellular Cryptogamia, especially of the Mosses and Liverworts.

In my 'Flora Columbiæ' (p. 41) I assimilate the spores of the Mosses with the polycotyledonous embryos of the Coniferæ, because the spores contained in the sporangia of Mosses, like the divided embryos of the Coniferæ, originate from the multiplication of a single fruitful cell, whilst the numerous embryos present in an embryo-sac of other Phanerogamia* have each a distinct and independent origin in its fluid.

If the fertilizing elements of the cellular Cryptogamia are morphologically so very unlike those of Phanerogamia, the analogy in the construction of the germ in these two great divisions of the vegetable kingdom cannot be extended further; for it is not known with certainty whether the fertilizing contents of *one* pollen-cell suffice for the complete development of several germs, nor whether one antherozoid is of equal value with one pollen-grain. And indeed, were this ascertained, the numerous simultaneous germs of the Mosses cannot be compared with the multipartite embryos of the Gymnospermæ and with the more numerous free embryos of the Angiospermæ; for the free central cell of the moss-sporangium would have to be regarded in the first case as a germ-cell, and in the second as an embryo-sac.

It follows, from our more recent acquaintance with the reproductive phenomena of the Linnæan Cryptogamia, first, *that the form of the reproductive processes is varied the more in direct proportion with the greater simplicity of the organs of vegetation; and secondly, that the number of germs developed as the result of an act of fertilization is the greater in the simpler-organized plants.*

The validity of this second law will be more thoroughly established by the consideration of the reproductive processes of the Lichens, on which I have made some remarks above.

Cœnogonium, Ehrenberg†.

Amended characters:—

Thallus discoideus in ambitu crescens, contextu stuppeo, e tubulis confervoideis, articulatis, subvirescentibus, strato corticali simplici filamentoso albido cancellatim vestitis intertextus. Apothecia terminalia et lateralia, primitus globosa, clausa, denique suborbiculata, scutelliformia, peltata, stipitata; hymenio (disco) aurantiaco; ascis sporigeris, paraphysibus cylindricis apice globosis mixtis; sporis octonis, ellipsoideis, bicellosis.

C. Linkii, Ehrenb.

Tubulorum articuli 0·045 mm. longi, 0·010 mm. in diam., gelatinam virescentem includentes; apothecia plerumque terminalia, subimmarginata.

Habitat in Brasilia.

* I observed from ten to twelve embryos in *Hymenocallis*, three or four in *Mangifera*, *Steriphoma*, and *Socratea*: Schacht, indeed, found as many as a hundred in *Citrus*.

† Horæ Physicæ Berolinenses, 1820, p. 120.

C. Andinum, Krst. Pl. XI.

Tubulorum articuli 0·12 mm. longi, 0·035 mm. in diametro, gelatinam virescentem includentes; apothecia plerumque lateralia, albide marginata.

Crescit in sylvis montuosis Novæ Granatæ et Venezuelæ ad arborum ramos; altitudine 5000–6000′.

The vital phenomena of this plant, together with the presence of an articulated central tube containing a green though formless colouring matter and apothecia, intimate its systematic position to be among the Lichens, where, indeed, both Ehrenberg and Koerber have placed it.

Each of the cylindrical fibres by the interweaving of which the thallus is formed consists, in the first place, of a central articulated cylinder, or a series of endogenous cells, the walls and septa of which are thickened, coloured blue by a solution of iodized chloride of zinc, and not dissolved in caustic potash; in the second, of a looser lamina of very delicate branched and anastomosing tubes which surround the central tube; and in the third place, of an equally delicate structureless cuticle which envelopes the whole plant. The two latter tissues are not coloured blue by the iodized chloride of zinc, whilst they dissolve in solution of potash.

The branching of the fibres is not very considerable; still it is sufficient, by the interweaving of all the horizontally-placed fibres and branches, to build up a complex thallus, which extends itself by a peripheral growth from the central portion, or the point by which it adheres to the twig of a tree.

The discoid apothecia are attached by a short pedicle to the sides of the fibres, in *C. Andinum*, as well upon the upper as on the under surface of all the fibres in the congeries forming the thallus: they are rarely affixed to the extremities of the fibres. The discoid apothecia are coloured orange-red and surrounded by a white border, which in the earlier phases of growth is very prominent.

The orange-coloured disk (*hymenium*) consists of fusiform tubes (figs. 1–6 & 15), which contain each eight bisected elliptical spores (fig. 12), and of somewhat longer '*paraphyses*,' similar in form to the spore-tubes, but with globular, enlarged extremities.

Both the spore-tubes and the paraphyses are supported on short jointed fibres (fig. 12), which are prolonged downwards into the parent-tissue (matrix), consisting of branched, jointed, anastomosing and interwoven narrow cylinders.

This matrix lies upon a similarly constructed tissue, consisting, however, of wider cylinders; which envelope and anastomose largely with it, forming its cortical layer as well as the margin of the apothecium.

The cortical or tegumentary lamina encloses in the first instance the whole rudimentary fruit-disk (hymenium) (figs. 2 & 11), and is burst asunder, during the development of the latter, at the summit of the growing apothecium, whilst it at the same time takes part with the upward growth of the tissue of the matrix and of the hymenium, and ends in the production of the ring or border.

On examining the apothecia in their earliest stage, they are seen to be formed very much in the same way as the young branches; yet throughout the process of development it is evident that the central cell of a simple branch is seated by a wide base upon the articulated stem-fibre (fig. 8), whilst in a branch which is to be converted into a sporangium it has a globular figure and lies on it like a free or independent corpuscle (figs. 7, 9, & 10 *a*). In a word, the youngest apothecium is globular, the young branch fusiform.

The further development of the cortical layer surrounding the central cell renders the distinction between the two structures particularly easy; for the delicate transparent mycelium-like fibres which are woven around the central cylinder of the fibres of the thallus are not uniformly extended to the archegonium, but form, by the generation of daughter-cells, a cell-like coat around the free, globular central cells.

This layer of smaller vesicular cells represents in this organ the cells of the archegonium of higher Cryptogamia which are coalesced into a cylinder.

Some of these vesicles elevate themselves above the surface of the archegonium, and at length detach themselves from the parent-cell (figs. 9 & 10), like the three "dot-cells" of the pollen of *Cœlebogyne* (Plate X.), or the numerous "dot-cells" of the pollen of Alsineæ; and they leave holes behind them in the integument, such as are also seen on the archegonium of *Saprolegnia*.

From the base of this globular apothecial structure (archegonium), the branches of the cortical layer simultaneously elevate themselves above the surface (fig. 7) and grow over the archegonium (as happens in *Coleochæte* and *Saprolegnia*), adhering closely to it, whilst here and there they dilate and form receptacles for a finely-granular mucoid fluid.

These dilatations are met with, as in *Saprolegnia*, above the small apertures left by the detachment of the "dot-cells," and at a later phase of existence are found empty.

Cell-growth now begins simultaneously in the green-coloured central-cell; four daughter-cells arise in it, whilst the surrounding cell-layer (the archegonium) becomes thicker and opake and conceals the enclosed cells.

Moreover the branches surrounding the archegonium as far as its apex ramify still more, particularly about the base, and attach the enlarging archegonium so much the more firmly to the parent branch as well as to other branches adjoining, and constitute for it an outer cortical layer (figs. 2 & 5 *a*, strongly compressed).

In thin longitudinal sections which contain the central tissue of the young archegonium, the centre may be seen entirely filled, for some time after the act of impregnation, with large, thin-walled cells, united in groups of four, containing a cloudy, gelatine-like matter. Some of these cells present no definitely formed corpuscles, whilst others (fig. 4) contain small granules and vesicles, but in no considerable quantity. By tearing and pressing the section under water, these collections of four adherent cells can be isolated.

Similar sections of archegonia of rather larger size show these large delicate cells, developed from the one central free cell of the archegonium, to be completely filled (fig. 3) with little ellipsoidal corpuscles, derived no doubt by an act of multiplication of the vesicles previously formed in the phase of development above described.

Longitudinal sections of still older but as yet closed archegonia (fig. 11), before they have become gorged with water, still display a central granular mass and groups of cells, from which the central tissue is progressively formed. When the section is thoroughly filled with absorbed fluid, this central tissue exhibits a homogeneous ellipsoidal mass, flattened at its two extremities; and whilst its base is enveloped by a cup-shaped lamina (derived from the modified cells of the archegonium) which is rather less porous than the cortical layer that surrounds the whole, its apex seems to be covered by large cells. The latter can no longer be detached. On tearing the preparation longitudinally, we ascertain that the large cells of the centre are conjoined with the adjacent layer of tissue, and that their apparently granular contents consist of long cylindrical cells, attached to the peripheral tissue, but free towards the centre.

These fibres are transitional forms in the development of spores and paraphyses; they have a mucilaginous appearance, are not quite uniformly cylindrical, but rather moniliform (fig. 13), as if the rudimentary spores were disposed in longitudinal rows next each other.

Moreover the archegonial cells (matrix) are now fibrous in form, like those of the cortical tissue, and are scarcely at all separable from the latter, or from the tubular layer, without laceration. All three varieties of the cells anastomose with one another, whence it happens that the tubes seem to be the ends of the cortical cells.

If this mode of development of the apothecium be compared with that of the sporangium of the foliaceous cellular Cryptogamia, we find that the at first free central cell of the archegonium of the latter, which becomes developed into the sporangium (whilst its downward-growing lower extremity, the future seta, coalesces with the receptaculum), presents an analogy with the cell from which the hymenium is developed, inasmuch as the peripheral ends of all its parts are united with the adjoining tissue.

The mother-cells of the spores are here retained after they are completely transformed into sporothecæ, whereas in the Mosses they become absorbed before the complete development of the spores. Instead of the *elaters* of the Hepaticæ, we here find among the Lichens the paraphyses.

By prolonged maceration in water the outer cortical layer becomes dissolved, and the young apothecia are resolved into endogenous cells, which are seen like rows of "daughter-cells" on the free branches (figs. 2 *a* & 5 *a*).

These cells recall in appearance those structures remarked by Itzigsohn, and called *spermatia*; however, I have not been fortunate enough to witness the antherozoid movements in them which Itzigsohn and Rabenhorst observed in the spermatia.

The act of impregnation of *Cœnogonium* recalls that of the conjugation of the two different branches of *Vaucheria* (Pl. IX. fig. 23), from the intermingling of the chemically different contents of which the formation of a germ proceeded. This circumstance, too, affords still stronger evidence of a sexual act, since, under altered vital conditions of the same plant, the same organs carried out the second form of fertilization, which most closely coincided with the normal proceeding (Pl. IX. figs. 24 *a* and 26 *a* & *b*).

The product of one act of fertilization is here, as among the Mosses and Hepaticæ and also some genera of Algæ (*Saprolegnia* and *Achlya*), not a single germ, but several or many; and between the process of impregnation seen in the last-named Alga and that in the *Cœnogonium* the closest similarity obtains, inasmuch as the archegonium does not receive the fructifying material on one side only, but simultaneously in several parts, after the fashion of the conjugation occurring among the Confervæ.

This history of the development of the apothecium of *Cœnogonium* points out the course we must pursue in order to convince ourselves what is the function of Itzigsohn's spermatia, and whether it be, as Rabenhorst and Tulasne imagine, sexual. It certainly cannot be the mother-cells of the spores which receive the fructifying material, but the original mother-cell of the entire hymenium contained in the archegonium. Where are we to seek for the archegonium? the history of the development of the apothecium will inform us.

Speerschneider has probably seen it in *Ramalina calicaris*, the walls of the gonidia of which, he says, he frequently saw beset with cell-like masses. To me, at least, it does not seem improbable that the archegonial cell of *Cœnogonium* has its equivalent in the gonidia of the Lichens with a foliaceous thallus; indeed this view is not supported by Speerschneider's observation, that gonidia also are developed into Lichens; but even this phenomenon, interpreted as a metamorphosis, is not in complete antagonism with that notion.

Similar laws of development hold good more surely in the case of the Fungi, which are so very similar to the Lichens in their organization. But here again we are not to expect to witness a fertilization of the *basidia* and *asci*, but have rather to seek it in the first rudiments of the pileus.

Ehrenberg has probably seen the fertilization of the *Amanita rosea*, and has described the conjugation of *Syzygites*; still, carried away by the idea that there must be one *single* germ as the immediate product of this process, he has not pursued the study of the further development of the plant.

That many of the structures described hitherto as species of Fungi are not actually plants at all, but only abnormally developed cells from the tissues of various plants and animals, is an assertion long since made by Reissek and myself.

I proved first the development of the yeast-plant from such cells of tissues and from the mycelium of Fungi, and I pointed out the necessity of instituting similar inquiries in various ways and on a large scale, so that we might ascertain the lowest limits which the specifically different multiplied plant-forms may reach by reproduction, and learn to distinguish these from diseased redundancies of elementary organs derived from the abnormal conditions in which plants are placed.

Bail and Hoffmann have in some measure corroborated these views; and I have myself often repeated these observations and extended my conclusions.

That the segments, separating in a spore-like form, of the pollen-tube developed in the form of a filamentous Fungus, are developed, not in the same, but in quite a different form, and consequently are not the members of a species of plants, was shown by me by that investigation; and it was proved by Hoffmann, Bary, Bail, Caspary, and others, that branches with differently formed spores are produced on one and the same mycelium. The signification of this fact is, at the present time, not understood: it is not known if those varieties in form are produced by variations in the mode of nutrition, and so far referable to those noticed by me as varieties or morbid productions, or if, as is possible, they are organs of dissimilar purpose, belonging to a particular species of Fungi and intended to carry out a sexual conjugation. In this latter case, it might be presumed that *Syzygites* is the prothallium of a more perfect form of Fungus.

The result of all these inquiries is, that all known species of plants possess, besides an asexual multiplication of individuals by cell-division or gemmation, a means of preserving the species by sexually developed germs, and that in these special reproductive organs a normal germ is never formed without the operation of a fertilizing material,—that, consequently, *parthenogenesis never occurs in plants.*

XXI.—*Description of a new Species of* Branchipus (B. eximius), *from the Pool of Gihon in Jerusalem.* By W. Baird, M.D., F.L.S.

[Plate XII.]

In the 'Annals and Magazine of Natural History' for Oct. 1859, I described five new species of Entomostraca, from the Pool of Gihon in Jerusalem. In that paper I mentioned that, in addition to those species forwarded to me alive by my friend Mr. Denny of Leeds, a pair of a species of what I then thought to be a *Chirocephalus*, from the same habitat, were kindly sent, but that they had died and become decomposed before I had the satisfaction of examining them. Since then, Mr. Denny has forwarded to me several specimens of the same Crustacean, also alive, reared from mud taken from the same pool at Jerusalem. A careful examination has proved them to belong to the genus *Branchipus*; and very elegant and beautiful little creatures they are. In their habits they closely resemble the *Chirocephalus diaphanus* found in this country, swimming chiefly on their back, and gracefully moving along, their numerous branchial feet being in constant motion. The females had their ovarian sacs full of ova, but they all died before these eggs were hatched. The following is a description of this interesting species:—

Branchipus eximius.

Body of a white colour. Tail fully the length of the body, and terminating in two lobes, which are beset with finely plumose setæ on their inner sides only. Outer edge showing a few (about twelve) short teeth near the base.